

We claim:

- ✓ 1 1. A method for measuring lens aberration, the method comprising:
2 providing a reticle having a test pattern, said test pattern
3 having a first feature and a second feature, said first feature
4 comprising a blazed grating capable of forming an asymmetric
5 pattern of illumination energy passing therethrough, said
6 asymmetric pattern rotationally oriented in a first direction;
7 exposing a photosensitive material to illumination energy
8 passing through said first and second features to form a first
9 feature image and a second feature image, respectively;
10 measuring a relative location of said first feature image with
11 respect to said second feature image; and
12 computing a lens aberration parameter in accordance with said
13 relative location. /
- ✓ 1 2. The method of claim 1 wherein, during the step of exposing, said
2 blazed grating projects a single beam.
- ✓ 1 3. The method of claim 1 wherein said test pattern comprises a box-
2 in-box pattern having an inner box and an outer box.
- ✓ 1 4. The method of claim 3 wherein said first feature comprises one
2 of said inner or outer box, and said first feature further
3 comprises a blazed grating having a first orientation.
- ✓ 1 5. The method of claim 4 wherein said second feature comprises the
2 remaining one of said inner or outer box, and said second feature
3 further comprises a blazed grating having a second orientation
4 different from said first orientation.
- ✓ 1 6. The method of claim 4 wherein said second feature comprises the

2 remaining one of said inner or outer box.

✓ 1 7. A method of measuring lens aberration comprising the steps:

2 providing a reticle having a plurality of test patterns, each
3 of said test patterns including and associated with a first feature
4 and a second feature, each of said first features having a blazed
5 grating, wherein each of said blazed gratings has an associated
6 grating orientation different from the orientation of each of the
7 others of said plurality of test patterns;

8 exposing a photosensitive material through said plurality of
9 test patterns to form a plurality of test images, each of said test
10 images having a first image formed from said first feature and an
11 associated second image formed from said second feature of the
12 associated test pattern;

13 measuring a relative location of said first image with respect
14 to said associated second image within each of said plurality of
15 test images to obtain a set of relative locations wherein each of
16 said relative locations in said set is associated with a different
17 grating orientation; and

18 computing a lens aberration property in accordance with said
19 set of relative locations.

✓ 1 8. The method of claim 7 wherein, during the step of exposing, each
2 of said blazed gratings projects a single beam.

✓ 1 9. The method of claim 7 wherein said each of said test patterns
2 comprises a box-in-box pattern having an inner box and an outer
3 box.

✓ 1 10. The method of claim 9 wherein said first feature comprises one
2 of said inner or outer box, and said first feature further
3 comprises a blazed grating having a first orientation.

✓ 1 11. The method of claim 10 wherein said second feature comprises
2 the remaining one of said inner or outer box.

3 12. The method of claim 1 wherein said test pattern further
4 comprises

5 a first vertical feature and a second vertical feature,
6 wherein said first vertical feature comprises a first vertical
7 blazed grating having a first horizontal orientation, and wherein
8 said second vertical feature comprises a second vertical blazed
9 grating having a second horizontal orientation pointing in a
10 direction opposite that of said first horizontal orientation,

11 said test pattern further comprising a first horizontal
12 feature and a second horizontal feature, wherein said first
13 horizontal feature comprises a first horizontal blazed grating
14 having a first vertical orientation, and wherein said second
15 horizontal feature comprises a second vertical orientation pointing
16 in a direction opposite that of said first vertical orientation,
17 and

18 said exposing further comprises forming first and second
19 vertical images associated with said first and second vertical
20 features, respectively, and forming said first and second
21 horizontal images associated with said first and second horizontal
22 features, respectively, and

23 said measuring further comprises measuring a vertical relative
24 location and a horizontal relative location, and wherein

25 said lens aberration property comprises focus aberration.

1 13. The method of claim 1 wherein said test pattern further
2 comprises

3 a box-in-box pattern having an outer box and an inner box
4 nested on a common center point, wherein said outer box comprises

5 upper and lower horizontal elements and left and right vertical
6 elements, said upper horizontal element comprising a blazed grating
7 having an orientation pointing vertically upward, said lower
8 horizontal element comprising a blazed grating having an
9 orientation pointing vertically downward, said left vertical
10 element comprising a blazed grating having an orientation pointing
11 to the left, said right vertical element comprising a blazed
12 grating having an orientation pointing to the right, and said inner
13 box providing zero degree phase shift, and wherein

14 said exposing further comprises forming outer and inner box
15 images associated with said outer box and said inner box,
16 respectively, and

17 said measuring comprises determining center points of said
18 outer and inner box images, and determining a shift of the center
19 of said outer box image relative to the center of said inner box
20 image, and wherein

21 said lens aberration property comprises coma.

✓ 1 14. A reticle for measuring lens aberration, the reticle
2 comprising a test pattern having a first feature and a second
3 feature, said first feature comprising a blazed grating capable of
4 forming an asymmetric pattern of illumination energy passing
5 therethrough and said asymmetric pattern rotationally oriented in
6 a first direction.

✓ 1 15. The reticle of claim 14 wherein said blazed grating is capable
2 of projecting a single beam.

✓ 1 16. The reticle of claim 14 wherein said test pattern comprises a
2 box-in-box pattern.

✓ 1 17. A reticle for measuring lens aberration, the reticle comprising

2 a plurality of test patterns, each of said test patterns including
3 and associated with a first feature and a second feature, each of
4 said first features comprising a blazed grating capable of forming
5 an asymmetric pattern of illumination energy passing therethrough,
6 said asymmetric pattern having a rotational orientation different
7 from the orientation of each of the other of said plurality of test
8 patterns.

✓ 18. The reticle of claim 17 wherein each of said plurality of test
2 patterns comprises a box-in-box pattern.

1 19. The reticle of claim 14 wherein said test pattern further
2 comprises a first vertical feature and a second vertical feature,
3 wherein said first vertical feature comprises a first vertical
4 blazed grating having a first horizontal orientation, and wherein
5 said second vertical feature comprises a second vertical blazed
6 grating having a second horizontal orientation pointing in a
7 direction opposite that of said first horizontal orientation,
8 said test pattern further comprising a first horizontal
9 feature and a second horizontal feature, wherein said first
10 horizontal feature comprises a first horizontal blazed grating
11 having a first vertical orientation, and wherein said second
12 horizontal feature comprises a second vertical orientation pointing
13 in a direction opposite that of said first vertical orientation.

1 20. The reticle of claim 14 wherein said test pattern further
2 comprises a box-in-box pattern having an outer box and an inner box
3 nested on a common center point, wherein said outer box comprises
4 upper and lower horizontal elements and left and right vertical
5 elements, said upper horizontal element comprising a blazed grating
6 having an orientation pointing vertically upward, said lower
7 horizontal element comprising a blazed grating having an

8 orientation pointing vertically downward, said left vertical
9 element comprising a blazed grating having an orientation pointing
10 to the left, said right vertical element comprising a blazed
11 grating having an orientation pointing to the right, and said inner
12 box providing zero degree phase shift.

10035061 113444